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(54) **METHOD OF MANUFACTURING A DISK DRIVE HEAD GIMBAL ASSEMBLY HAVING A FLEXURE TAIL WITH FOLDED BOND PADS**

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See application file for complete search history.

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(57) **ABSTRACT**

A method to manufacture a head stack assembly for a disk drive, the method comprising: attaching a head gimbal assembly that includes a flexure tail having flexure bond pads to an actuator that includes a flexible printed circuit (FPC) with FPC bond pads; folding each of the flexure bond pads upon itself such that the flexure tail is substantially thicker at each of the folded flexure bond pads; aligning the flexure bond pads with the FPC bond pads; introducing an adhesive material that includes electrically conductive beads of substantially similar size between each of the flexure bond pads and corresponding ones of the FPC bond pads; and bringing a thermode tool into contact with the flexure bond pads after folding, with the thermode tool pressing the flexure bond pads against the FPC bond pads for a period.
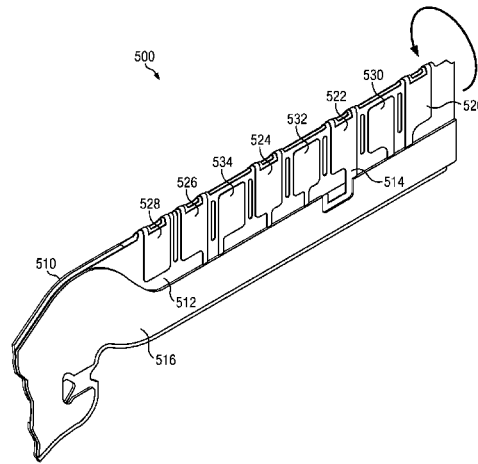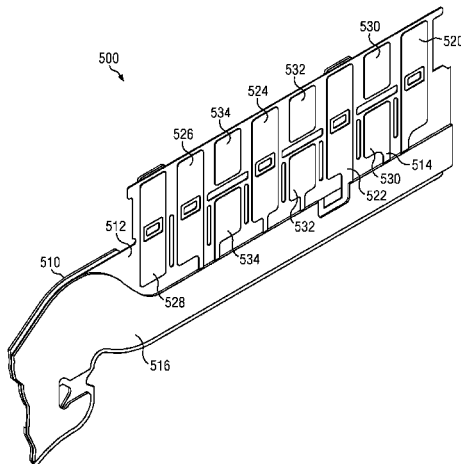
10 Claims, 9 Drawing Sheets

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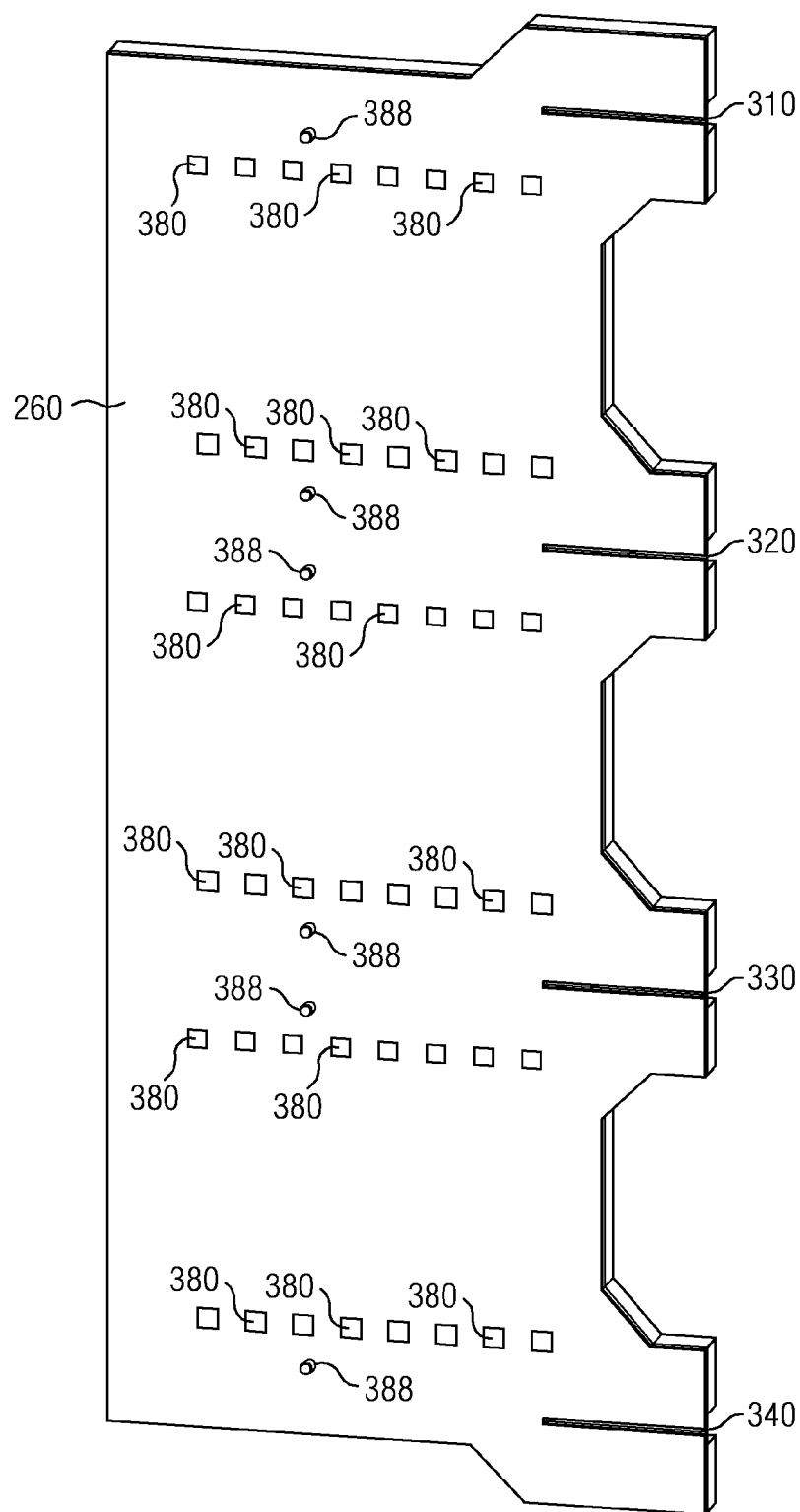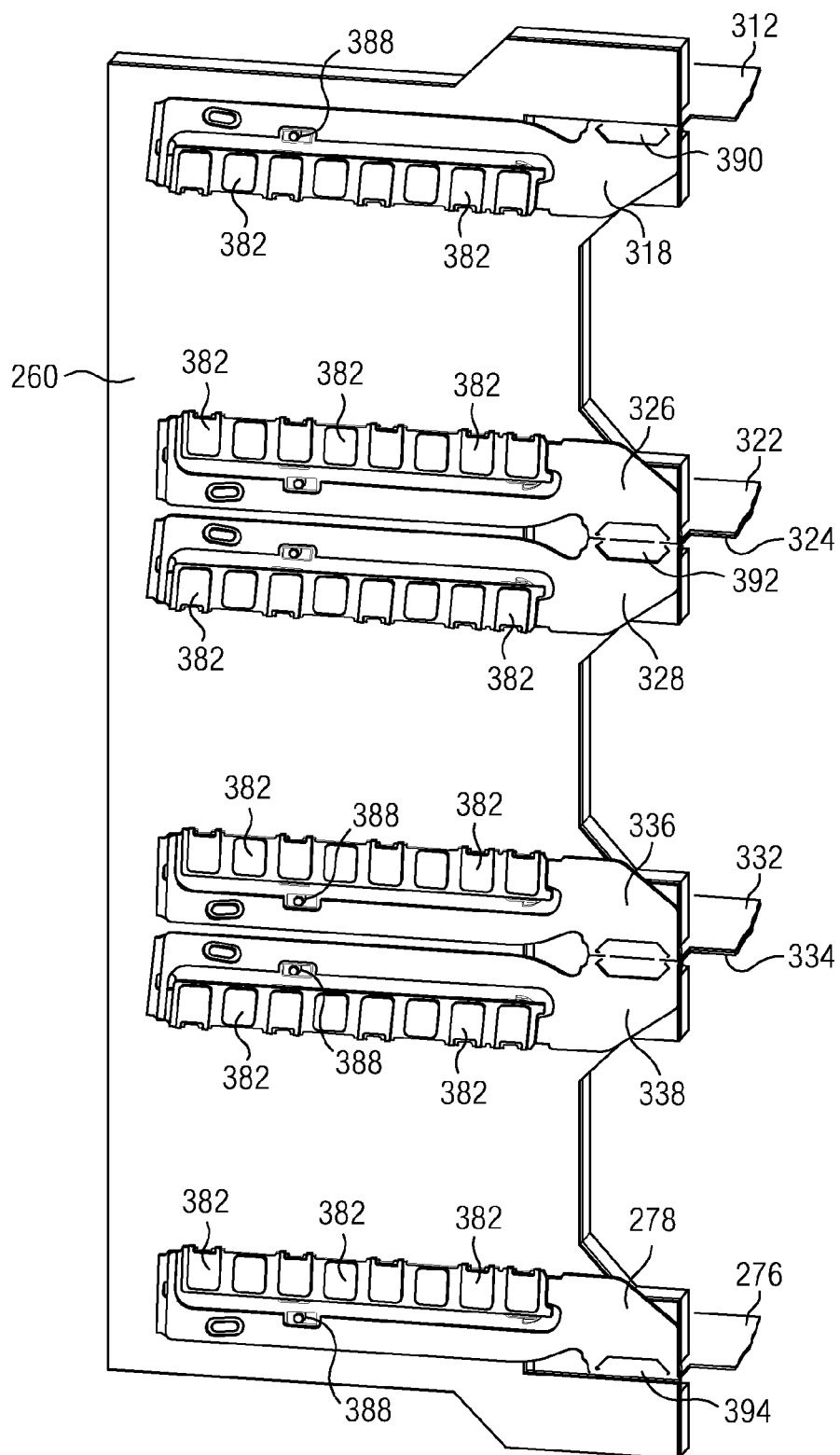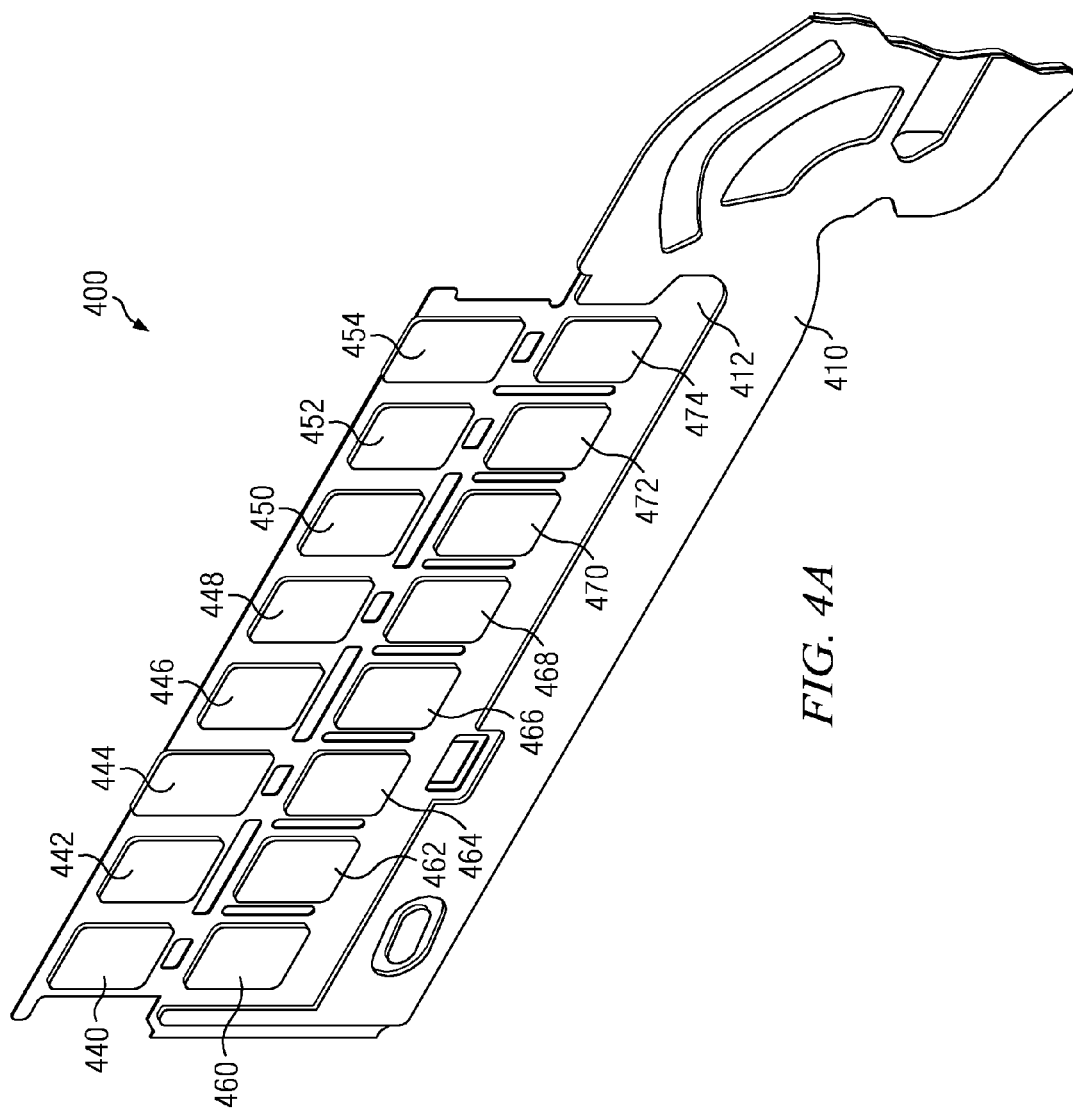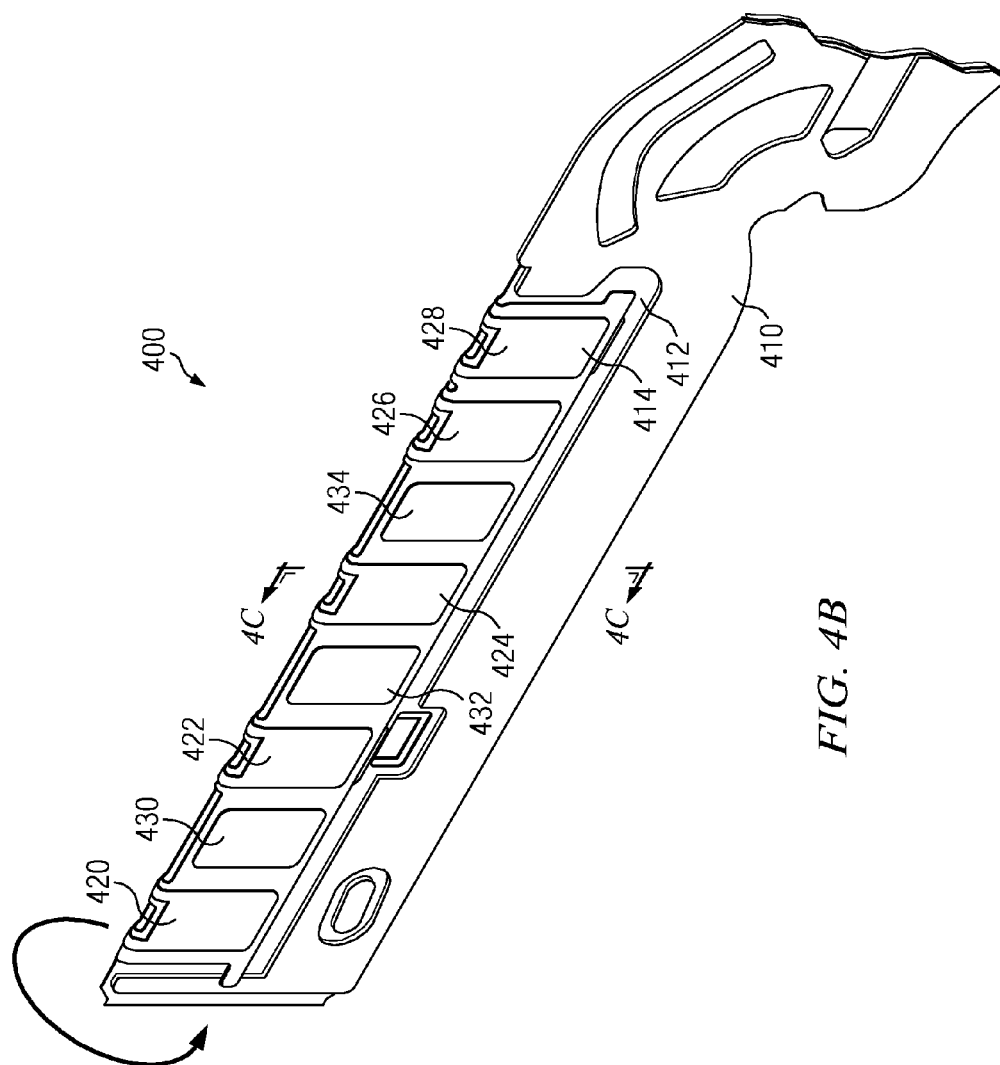
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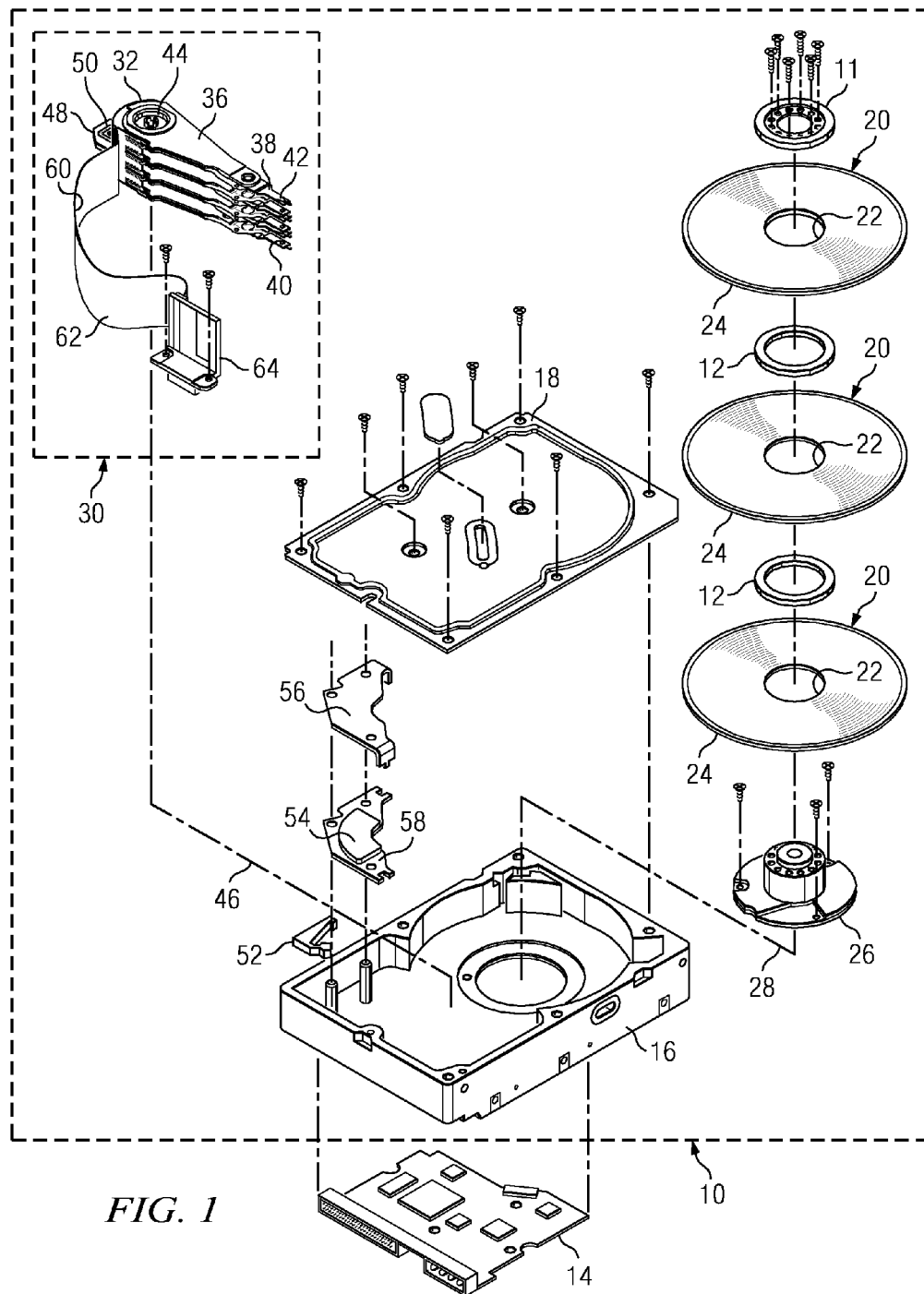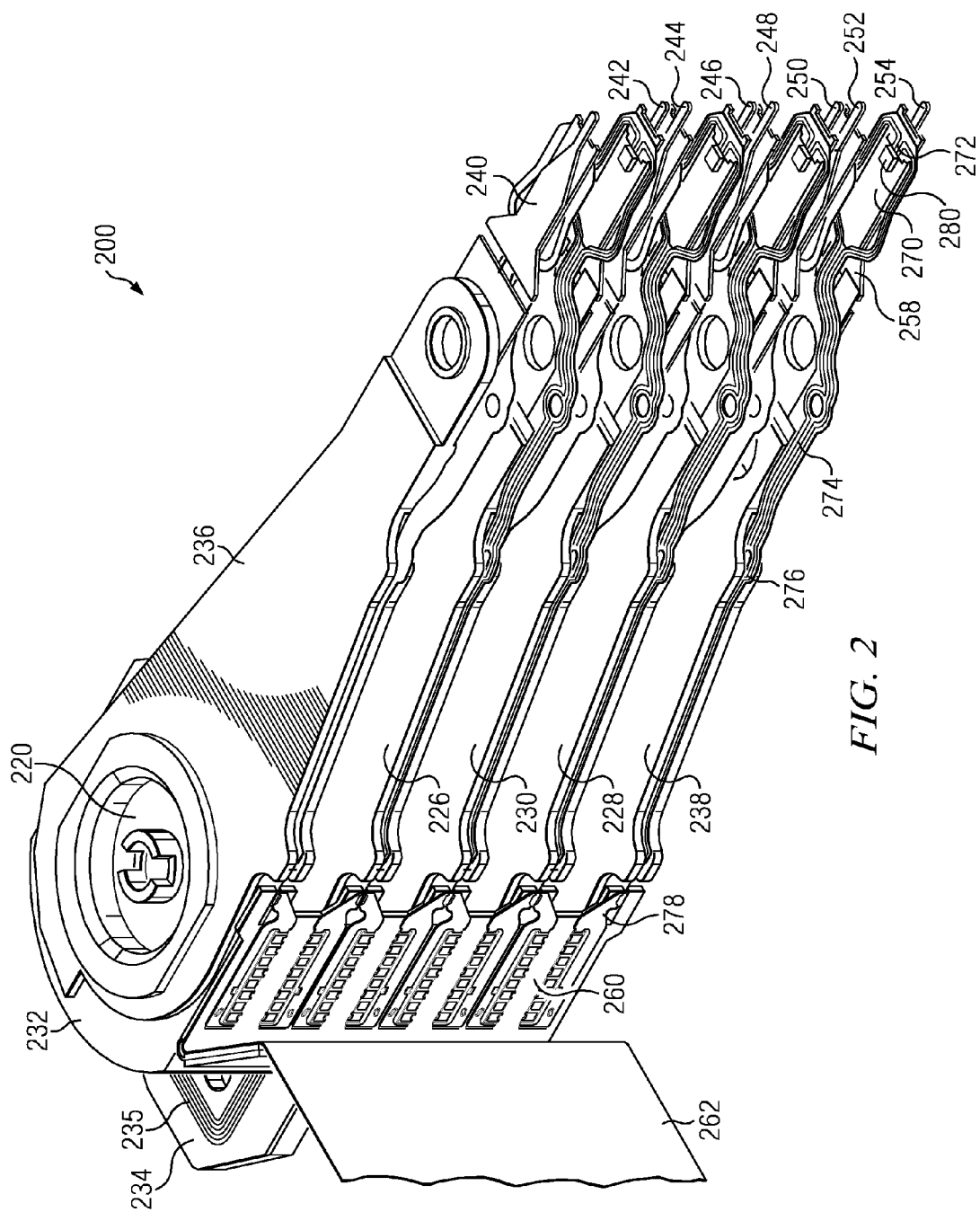
FIG. 1
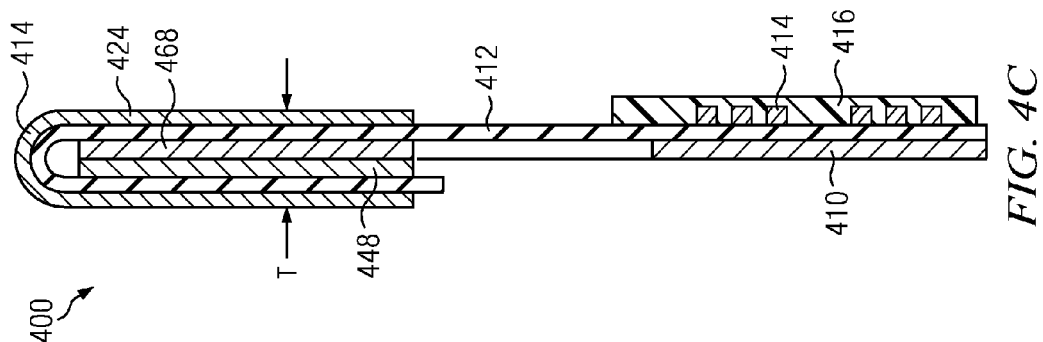
FIG. 2

FIG. 3A

FIG. 3B

FIG. 4A

414
424
468

412

414
416

400

448
T

410

FIG. 4C

400

428
426
434

422
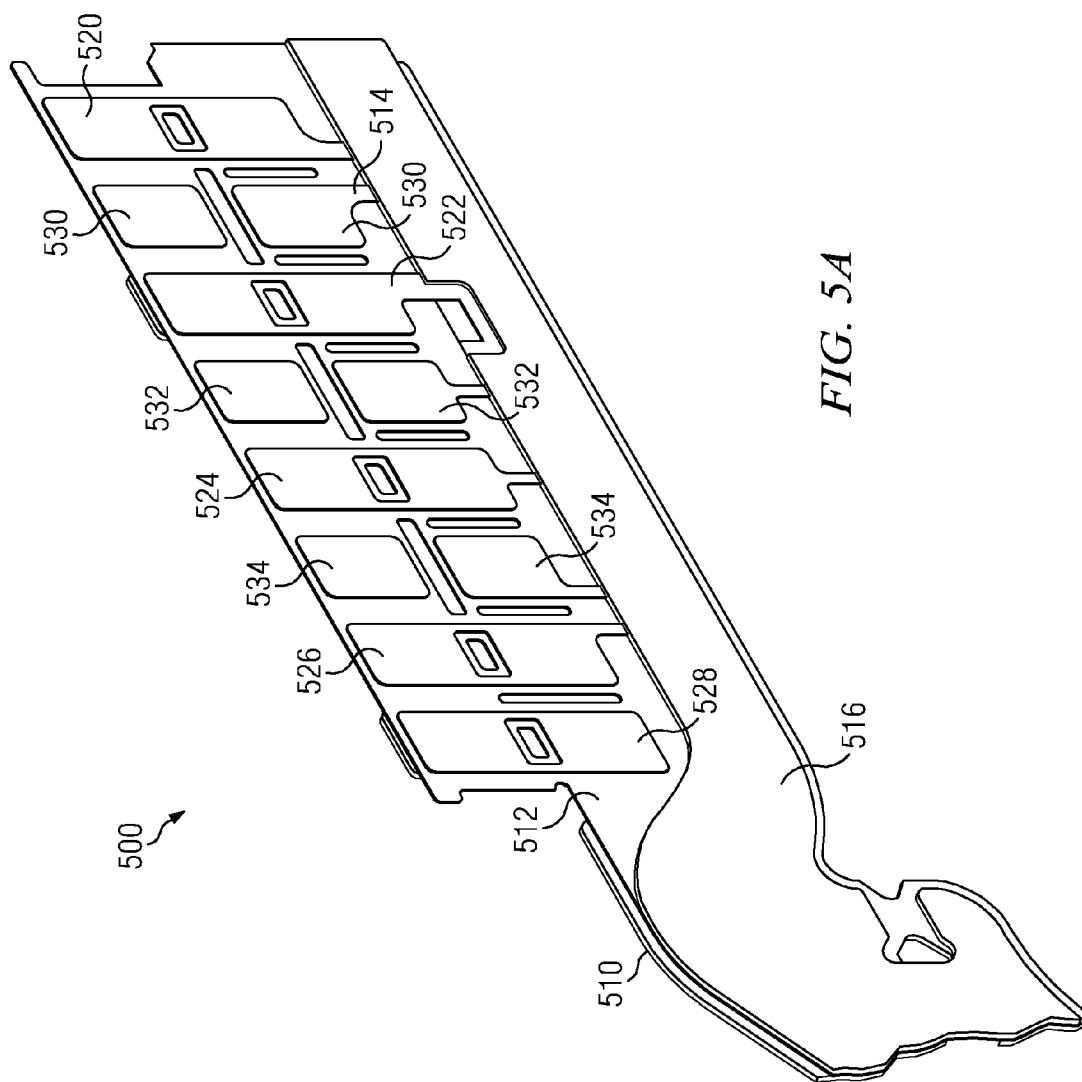430
420

432
424
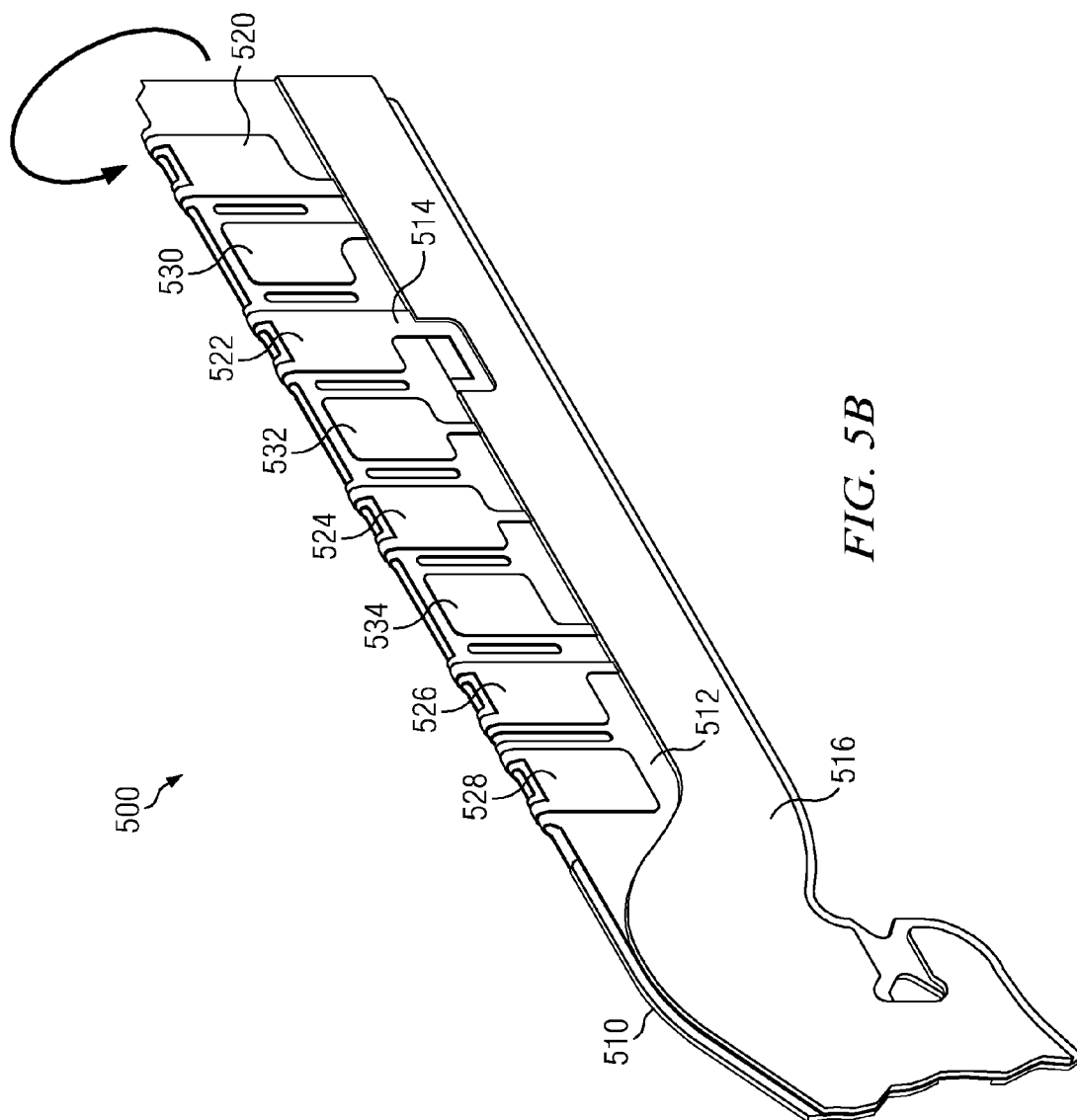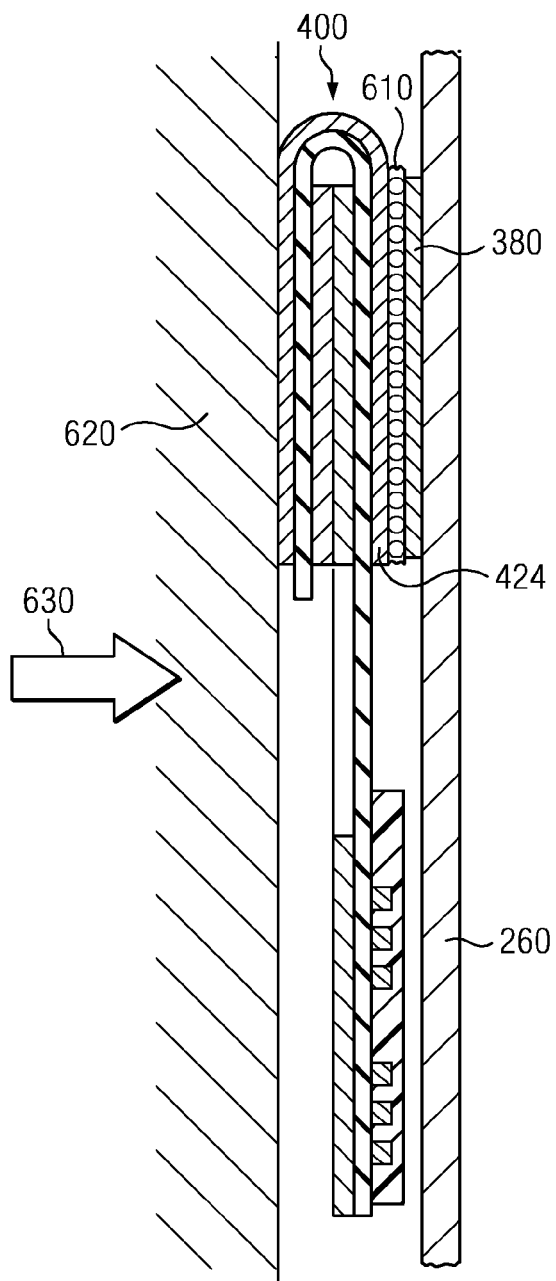
414
412
410

FIG. 4B

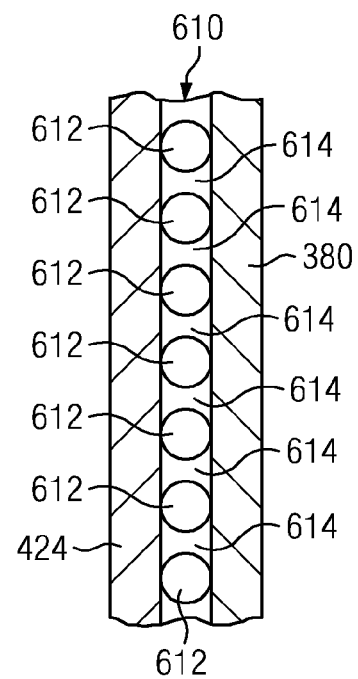*FIG. 5A*

FIG. 5B

FIG. 6A

FIG. 6B

METHOD OF MANUFACTURING A DISK DRIVE HEAD GIMBAL ASSEMBLY HAVING A FLEXURE TAIL WITH FOLDED BOND PADS

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application is a divisional of U.S. patent application Ser. No. 12/916,237, filed on Oct. 29, 2010, entitled "DISK DRIVE HEAD GIMBAL ASSEMBLY HAVING A FLEXURE TAIL WITH FOLDED BOND PADS," now issued as U.S. Pat. No. 8,467,153, which is hereby incorporated by reference in its entirety.

BACKGROUND

Information storage devices are used to retrieve and/or store data in computers and other consumer electronics devices. A magnetic hard disk drive is an example of an information storage device that includes one or more heads that can both read and write, but other information storage devices also include heads—sometimes including heads that cannot write.

In a modern magnetic hard disk drive device, each head is a sub-component of a head-gimbal assembly (HGA) that typically includes a laminated flexure to carry the electrical signals to and from the head. The HGA, in turn, is a sub-component of a head-stack assembly (HSA) that typically includes a plurality of HGAs, an actuator, and a flexible printed circuit (FPC). The plurality of HGAs are attached to various arms of the actuator.

Modern laminated flexures typically include conductive copper traces that are isolated from a stainless steel structural layer by a polyimide dielectric layer. So that the signals from/to the head can reach the FPC on the actuator body, each HGA flexure includes a flexure tail that extends away from the head along a corresponding actuator arm and ultimately attaches to the FPC adjacent the actuator body. That is, the flexure includes traces that extend from adjacent the head and continue along the flexure tail to electrical connection points. The FPC includes conductive electrical terminals that correspond to the electrical connection points of the flexure tail.

To facilitate electrical connection of the conductive traces of the flexure tails to the conductive electrical terminals of the FPC during the HSA manufacturing process, the flexure tails must first be properly positioned relative to the FPC so that the conductive traces of the flexure tails are aligned with the conductive electrical terminals of the FPC. Then the flexure tails must be held or constrained against the conductive electrical terminals of the FPC while the aforementioned electrical connections are made (e.g. by ultrasonic bonding, solder jet bonding, or solder bump reflow).

However, recently for some disk drive products, the aforementioned electrical connections may employ a type of anisotropic conductive film (ACF) bonding. An anisotropic conductive film is typically an adhesive doped with conductive beads or cylindrical particles of uniform or similar diameter. As the doped adhesive is compressed and cured, it is squeezed between the surfaces to be bonded with sufficient uniform pressure that a single layer of the conductive beads makes contact with both surfaces to be bonded. In this way, the thickness of the adhesive layer between the bonded surfaces becomes approximately equal to the size of the conductive beads. The cured adhesive film may conduct electricity via the contacting beads in a direction normal to the bonded surfaces (though may not necessarily conduct electricity par-

allel to the bonded surfaces, since the beads may not touch each other laterally—though axially each bead is forced to contact both of the surfaces to be bonded—hence the term "anisotropic").

Maintaining sufficient uniform pressure during adhesive curing, such that a single layer of conductive beads in an ACF makes contact with both opposing surfaces to be bonded, may be achievable for existing HGA designs using a tool that presses only upon a single bond pad. However, in a high-volume manufacturing environment like that necessitated by the very competitive information storage device industry, there is a practical requirement for fast, cost-effective, and robust bonding of many bond pads simultaneously; bonding one bond pad at a time simply takes too much time.

Accordingly, there is a need in the art for an improved HGA design that may facilitate the application of more uniform pressure to groups of bond pads, to more quickly accomplish reliable electrical connection of the conductive traces of a flexure tail to the conductive electrical terminals of a FPC (e.g. by ACF or by any other bonding method that benefits from a more uniform bonding pressure) during HSA manufacture.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of a disk drive according to an embodiment of the present invention.

FIG. 2 is a perspective view of a head stack assembly (HSA) according to an embodiment of the present invention.

FIG. 3A is a perspective view of a portion of a flexible printed circuit (FPC) according to an embodiment of the present invention.

FIG. 3B is a perspective view of a plurality of flexure tail terminal regions attached to the FPC portion of FIG. 3A, according to an embodiment of the present invention.

FIG. 4A depicts a flexure tail terminal region before folding, according to an embodiment of the present invention.

FIG. 4B depicts a flexure tail terminal region after folding, according to an embodiment of the present invention.

FIG. 4C depicts a cross-section of the folded flexure tail terminal region of FIG. 4B.

FIG. 5A depicts a flexure tail terminal region before folding, according to an embodiment of the present invention.

FIG. 5B depicts a flexure tail terminal region after folding, according to an embodiment of the present invention.

FIG. 6A depicts the bonding of a flexure bond pad to a corresponding flexible printed circuit bond pad by an anisotropic conductive film, according to an embodiment of the present invention.

FIG. 6B is an expanded view of a portion of FIG. 6A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is an exploded perspective view of a disk drive according to an example embodiment of the present invention. The disk drive includes a head disk assembly (HDA) 10 and a printed circuit board assembly (PCBA) 14. The HDA 10 includes a base 16 and cover 18 that together house at least one annular magnetic disk 20. Each disk 20 contains a plurality of magnetic tracks for storing data. The tracks are disposed upon opposing first and second disk surfaces of the disk 20 that extend between an inner disk edge 22 (corresponding to the inner diameter) and an outer disk edge 24 (corresponding to the outer diameter) of the disk 20. The head disk assembly 10 further includes a spindle motor 26 for rotating the disk 20 about a disk axis of rotation 28. The

spindle motor **26** includes a spindle motor hub that is rotatably attached to the base **16** of the HDA **10**. Disks **20** may be stacked and separated with one or more annular disk spacers **12** that are disposed about the hub, all held fixed to the hub by disk clamp **11**.

The HDA **10** further includes a head stack assembly (HSA) **30** rotatably attached to the base **16** of HDA **10**. The HSA **30** includes an actuator comprising an actuator body **32** and one or more actuator arms **36** extending from the actuator body **32**. The actuator body **32** includes a bore **44** and a pivot bearing cartridge engaged within the bore for facilitating the HSA **30** to rotate relative to HDA **10** about actuator pivot axis **46**. One or two head gimbal assemblies (HGA) **38** are attached to a distal end of each actuator arm **36**. Each HGA includes a head (e.g. head **40**) for reading and writing data from and to the disk **20**, and a load beam **42** to compliantly preload the head against the disk **20**. The HSA **30** further includes a coil support **48** that extends from one side of the HSA **30** that is opposite head **40**. The coil support **48** is configured to support a coil **50** through which a changing electrical current is passed. The coil **50** interacts with one or more magnets **54** that are attached to base **16** via a yoke structure **56**, **58** to form a voice coil motor for controllably rotating the HSA **30**. HDA **10** includes a latch **52** rotatably mounted on base **16** to prevent undesired rotations of HSA **30**.

The PCBA **14** includes a servo control system for generating servo control signals to control the current through the coil **50** and thereby position the HSA **30** relative to tracks disposed upon surfaces of disk **20**. The HSA **30** is electrically connected to PCBA **14** via a flexible printed circuit (FPC) **60**, which includes a flex cable **62** and a flex cable support bracket **64**. The flex cable **62** supplies current to the coil **50** and carries signals between the HSA **30** and the PCBA **14**.

In the magnetic hard disk drive of FIG. **1**, the head **40** includes a body called a "slider" that carries a magnetic transducer on its trailing end (not visible given the scale of FIG. **1**). The magnetic transducer may include an inductive write element and a magnetoresistive read element. During operation the transducer is separated from the magnetic disk by a very thin hydrodynamic air bearing. As the motor **26** rotates the magnetic disk **20**, the hydrodynamic air bearing is formed between an air bearing surface of the slider of head **40**, and a surface of the magnetic disk **20**. The thickness of the air bearing at the location of the transducer is commonly referred to as "flying height."

FIG. **2** is a perspective view of a head stack assembly (HSA) **200** according to an example embodiment of the present invention. The HSA **200** includes an actuator body **232** and a plurality of actuator arms **226**, **228**, **230**, **236**, **238** extending from the actuator body **232**. The actuator body **232** includes a pivot bearing cartridge **220** disposed in the actuator bore, and a coil support **234** that supports a coil **235** and extends from the actuator body **232** in a direction that is generally opposite the actuator arms **226**, **228**, **230**, **236**, **238**. The HSA **200** also includes a plurality of head gimbal assemblies (HGA) **240**, **242**, **244**, **246**, **248**, **250**, **252**, **254**, attached to the actuator arms **226**, **228**, **230**, **236**, **238**. For example, such attachment may be made by swaging. Note that each of the inner actuator arms **226**, **228**, **230** includes two HGAs, while each of the outer actuator arms **236**, **238**, includes only one HGA. This is because in a fully populated disk drive the inner arms are positioned between disk surfaces while the outer actuator arms are positioned over (or under) a single disk surface. In a depopulated disk drive, however, any of the actuator arms may have one or zero HGAs, possibly replaced by a dummy mass.

Each HGA includes a head for reading and/or writing to an adjacent disk surface (e.g. HGA **254** includes head **280**). The head **280** is attached to a tongue portion **272** of a laminated flexure **270**. The laminated flexure **270** is part of the HGA **254**, and is attached to a load beam **258** (another part of the HGA **254**). The laminated flexure **270** may include a structural layer (e.g. stainless steel), a dielectric layer (e.g. polymide), and a conductive layer into which traces are patterned (e.g. copper). The HSA **200** also includes a flexible printed circuit (FPC) **260** adjacent the actuator body **232**, and the FPC **260** includes a flex cable **262**. The FPC **260** may comprise a laminate that includes two or more conventional dielectric and conductive layer materials (e.g. one or more polymeric materials, copper, etc). The laminated flexure **270** includes a flexure tail **274** that includes an intermediate region **276** that is disposed adjacent the actuator arm **238**, and a terminal region **278** that is electrically connected to bond pads of the FPC **260**.

Methods of electrical connection of the flexure tails to the FPC **260** include solder reflow, solder ball jet (SBJ), and anisotropic conductive film (ACF) bonding, and are preferably but not necessarily automated. To electrically connect and securely attach the flexure tails to the FPC **260**, the flexure tails are first aligned with the FPC **260**, and then pressed against the FPC **260** (at least temporarily) while electrical connection is established and secure attachment is completed. Maintaining sufficient uniform pressure to groups of bond pads may be desirable during this process, and may be facilitated by certain inventive structural features in the terminal regions of the flexure tails.

For example, FIG. **3B** is a perspective view of a plurality of flexure tail terminal regions **278**, **318**, **326**, **328**, **336**, **338** that are electrically connected to the FPC **260**, according to an embodiment of the present invention. FIG. **3A** depicts the FPC **260** before the flexure tail terminal regions **278**, **318**, **326**, **328**, **336**, **338** are bonded thereto. Now referring to FIGS. **3A** and **3B**, the FPC **260** includes electrical conduits that terminate at FPC bond pads **380** which are aligned with and connected to flexure bond pads **382** of the terminal regions **278**, **318**, **326**, **328**, **336**, **338** of the HGA flexure tails.

As shown in FIG. **3B**, each of the flexure tail terminal regions **278**, **318**, **326**, **328**, **336**, **338** optionally includes an alignment hole to accommodate the alignment posts **388**. Moreover, each of the flexure tail intermediate regions **276**, **312**, **322**, **324**, **332**, **334** may extend into one of the slits **310**, **320**, **330**, **340**. Note that in the example embodiment of FIGS. **3A-B**, each of the flexure tails is bent near a corresponding slit so that each of the flexure tail terminal regions **278**, **318**, **326**, **328**, **336**, **338** is substantially orthogonal to the intermediate region **276**, **312**, **322**, **324**, **332**, **334** of the same flexure tail. In the embodiment of FIG. **3B**, such bending may be facilitated by an optional hexagonal opening (e.g. hexagonal opening **390**, **392**, or **394**) extending through each of the flexure tails that is depicted.

FIG. **4A** depicts a close up perspective view of a flexure tail terminal region **400** of a laminate flexure, before its bond pads are folded upon themselves according to an example embodiment of the present invention. FIG. **4B** shows the flexure tail terminal region **400** after its bond pads are folded upon themselves, and FIG. **4C** depicts a cross section of FIG. **4B**. Now referring additionally to FIGS. **4A-C**, the flexure tail terminal region **400** of the laminate flexure comprises a structural layer **410**, a dielectric layer **412**, and a conductive layer **414**. In certain embodiments, the structural layer **410** comprises stainless steel, the dielectric layer **412** comprises polyimide, and the conductive layer **414** comprises copper, for example, though it is contemplated that other materials providing simi-

lar function might be used instead. Certain embodiments optionally further comprise an insulative cover layer **416** (e.g. a polymeric material), that covers and insulates portions of the conductive layer **414**.

The flexure tail terminal region **400** includes a plurality of flexure bond pads **420**, **422**, **424**, **426**, **428**, each of which aligned with a corresponding one of the plurality of FPC bond pads **380**. The flexure tail terminal region **400** also includes flexure bond pads **430**, **432**, **434**, which are also aligned with corresponding ones of the plurality of FPC bond pads **380**. Each of the plurality of flexure bond pads **420**, **422**, **424**, **426**, **428**, **430**, **432**, and **434** is folded upon itself. In certain embodiments, folding each of the plurality of flexure bond pads **420**, **422**, **424**, **426**, **428**, **430**, **432**, and **434** upon itself comprises simultaneously folding all of the plurality of flexure bond pads **420**, **422**, **424**, **426**, **428**, **430**, **432**, and **434** by folding the terminal region **400** of the flexure tail upon itself. In an alternative embodiment, one or more individual bond pads may be folded non-simultaneously with others. In certain embodiments of the present invention, the folding of the flexure tail terminal region **400** at the bond pad locations may precede alignment with the FPC bond pads **380**, whereas in other embodiments alignment with FPC bond pads **380** may precede folding.

Before folding, the flexure bond pads **420**, **422**, **424**, **426**, **428**, **430**, **432**, and **434** are not visible in FIG. **4A** because they are disposed on the side of the flexure tail terminal region **400** that is facing away from the viewer. After folding, portions of the flexure bond pads **420**, **422**, **424**, **426**, **428**, **430**, **432**, and **434** are visible in FIG. **4B**. In the case of flexure bond pads **420**, **422**, **424**, **426**, **428**, the portions depicted in FIG. **4B** are shown to be electrically continuous with corresponding portions (on the side of the flexure tail terminal region **400** that is facing away from the viewer) that would be electrically connected to the FPC bond pads **380**. In the case of flexure bond pads **430**, **432**, and **434**, however, the portions depicted in FIG. **4B** are shown to be electrically discontinuous with portions (on the side of the flexure tail terminal region **400** that is facing away from the viewer) that would be electrically connected to the FPC bond pads **380**.

In the embodiment of FIGS. **4A-C**, a plurality of backing plates **440**, **442**, **444**, **446**, **448**, **450**, **452**, **454**, **460**, **462**, **464**, **466**, **468**, **470**, **472**, and **474** are defined in the structural layer **410** and are disposed in general alignment with corresponding flexure bonding pads. For example, a pair of backing plates **440**, **460** are disposed in general alignment with bond pad **420**. Likewise, a pair of backing plates **442**, **462** are disposed in general alignment with bond pad **430**. As shown best in FIG. **4C**, upon folding, the two backing plates (e.g. **448**, **468**) of each backing plate pair may be brought into facing contact with each other to increase the thickness of the folded flexure tail terminal region **400** at the locations of the bond pads (e.g. at the location of the flexure bond pad **424**).

For example, as shown in FIG. **4C**, the laminate flexure may define a total folded thickness T at each of the plurality of flexure bond pads that is at twice a thickness of the structural layer, plus twice a thickness of the dielectric layer, plus twice a thickness of the conductive layer (or more, e.g. if surface irregularities, contaminates, and/or additional layers are present). For example, the thickness of the structural layer may be less than 20 microns, the thickness of the dielectric layer may be less than 15 microns, the thickness of the conductive layer may be less than 15 microns, and yet the total folded thickness T may be at least 60 microns.

FIG. **5A** depicts a close up perspective view of a flexure tail terminal region **500** of a laminate flexure, before its bond pads are folded upon themselves according to an example embodi-

ment of the present invention. FIG. **5B** shows the flexure tail terminal region **500** after its bond pads are folded upon themselves. Now referring additionally to FIGS. **5A-B**, the flexure tail terminal region **500** of the laminate flexure comprises a structural layer **510**, a dielectric layer **512**, and a conductive layer **514**. In certain embodiments, the structural layer **510** comprises stainless steel, the dielectric layer **512** comprises polyimide, and the conductive layer **514** comprises copper, for example, though it is contemplated that other materials providing similar function might be used instead. Certain embodiments optionally further comprise an insulative cover layer **516** (e.g. a polymeric material), that covers and insulates portions of the conductive layer **514**.

The flexure tail terminal region **500** includes a plurality of flexure bond pads **520**, **522**, **524**, **526**, **528**, each of which aligned with a corresponding one of the plurality of FPC bond pads **380**. The flexure tail terminal region **500** also includes flexure bond pads **530**, **532**, **534**, which are also aligned with corresponding ones of the plurality of FPC bond pads **380**. Each of the plurality of flexure bond pads **520**, **522**, **524**, **526**, **528**, **530**, **532**, and **534** is folded upon itself.

Before folding, flexure bond pads **520**, **522**, **524**, **526**, **528**, **530**, **532**, and **534** are fully visible in FIG. **5A**. That is, in FIG. **5A**, both the upper portions and lower portions of the flexure bond pads **520**, **522**, **524**, **526**, **528**, **530**, **532**, and **534** are visible. After folding, the upper portions of the flexure bond pads **520**, **522**, **524**, **526**, **528**, **530**, **532**, and **534** are not visible in FIG. **4B** because such portions are disposed on the side of the flexure tail terminal region **500** that is facing away from the viewer. In certain embodiments, one or more of such upper portions may be covered by the insulative cover layer **516**.

In the case of flexure bond pads **520**, **522**, **524**, **526**, **528**, the lower portions depicted in FIG. **5B**, that would be electrically connected to the FPC bond pads **380**, are shown to be electrically continuous with corresponding upper portions on the side of the flexure tail terminal region **500** that is facing away from the viewer. In certain cases, this may be done to facilitate contact with probes for electrical test. In the case of flexure bond pads **530**, **532**, and **534**, however, the lower portions depicted in FIG. **5B**, that would be electrically connected to the FPC bond pads **380**, are shown to be electrically discontinuous with corresponding upper portions on the side of the flexure tail terminal region **500** that is facing away from the viewer.

In certain embodiments, each of the flexure bond pads (e.g. flexure bond pad **424** in the embodiment of FIGS. **4A-C**) may be bonded to a corresponding one of the plurality of FPC bond pads **380** by an anisotropic conductive film (ACF). For example, FIGS. **6A-B** depict the bonding of a flexure bond pad **424** to a corresponding FPC bond pad **380** by an ACF **610**. A thermode tool **620** is brought into contact with the plurality of flexure bond pads after folding, with the thermode tool **620** pressing the plurality of flexure bond pads (e.g. including flexure bond pad **424**) against the plurality of FPC bond pads (e.g. including the corresponding FPC bond pad **380**) for a period. In this context, one of ordinary skill would understand that the phrase "after folding" does not necessarily mean immediately after folding; rather, there could be intermediate steps.

The ACF **610** may comprise an adhesive material **614** that includes a plurality of electrically conductive beads **612** of substantially similar diameter. In certain embodiments the ACF **610** may employ beads of non-spherical shape, such as cylindrical beads. In certain embodiments the adhesive material **614** may be deposited on to FPC bond pad **380** prior to aligning the flexure bond pad **424** thereto. Alternatively, the

adhesive material **614** may be deposited on to a first side of the flexure bond pad **424** (facing the FPC bond pad **380**), after folding and prior to bringing the thermode tool **620** into contact with an opposing second side of the flexure bond pad **424** (facing the thermode tool **620**).

As shown in FIGS. 6A-B, the force **630** that presses (via the thermode tool **620**) the flexure bond pad **424** against FPC bond pad **380** during the period of bonding, may arrange the plurality of electrically conductive beads **612** in a monolayer with each of the plurality of electrically conductive beads **612** in electrical contact with the flexure bond pad **424** and the corresponding FPC bond pad **380**. The thermode tool **620** may also transfer heat through flexure bond pad **424** during the period of bonding, and raise the temperature of the adhesive material **614** during such period, for example to accelerate curing of the adhesive material **614**.

In certain embodiments, the force **630** of the thermode tool **620** is sufficient to cause the electrically conductive beads **612** to be substantially elastically deformed in compression between the flexure bond pad **424** and the corresponding FPC bond pad **380** during the period of thermal curing of the adhesive material **614**. After the thermode tool **620** is removed, the electrically conductive beads **612** cool (with the cured adhesive) from an elevated curing temperature. Such cooling causes the electrically conductive beads **612** to shrink relative to their expanded size during thermal curing of the adhesive material **614**.

However, the force **630** is preferably chosen to be great enough that the post-curing shrinkage of the electrically conductive beads **612** cannot completely relieve the compressive deformation of the electrically conductive beads **612** that was experienced during curing. Hence, after curing of the adhesive material **614**, and after removal of the thermode tool **620**, the electrically conductive beads **612** may remain in compression (and somewhat compressively deformed) between the flexure bond pad **424** and the corresponding FPC bond pad **380**.

Although residual compression of the electrically conductive beads **612** may correspond to some residual tension in the cured adhesive material **614**, the such residual compression of the electrically conductive beads **612** may be desirable to enhance and ensure reliable electrical conductivity of the ACF **610**. For example, in the case where the electrically conductive beads **612** are spherical, the residual compression may cause small flat spots where the electrically conductive beads **612** contact the flexure bond pad **424** and the corresponding FPC bond pad **380**. Such flat spots can provide a finite contact areas rather than point contacts, which may desirably reduce the electrical resistance of the ACF **610**.

To help facilitate higher volume manufacturing, the thermode tool **630** may include a flat surface that is substantially larger than any of the plurality of flexure bond pads, for example so that many bond pads may be subjected to the applied pressure and heat transfer simultaneously. The localized flexure tail thickness increases at the location of the bond pads, that result from folding the flexure tail **400** as shown and described previously with reference to FIG. 4C, may advantageously allow a large flat thermode tool (e.g. thermode tool **630**) to provide pressure and heat only to the bond pad locations—without a need to first pattern or precisely align the thermode tool **630**. This may advantageously simplify high volume manufacture. That is, in certain embodiments of the present invention, the local thickness variations of the flexure tail **400**, that is caused by folding, may act as a self-aligning pattern to augment and assist the thermode tool to selectively

apply pressure and heat more to desired bond pad locations of the flexure tail **400** than to undesired locations (e.g. locations away from the bond pads).

In the foregoing specification, the invention is described with reference to specific exemplary embodiments, but those skilled in the art will recognize that the invention is not limited to those. It is contemplated that various features and aspects of the invention may be used individually or jointly and possibly in a different environment or application. The specification and drawings are, accordingly, to be regarded as illustrative and exemplary rather than restrictive. For example, the word "preferably," and the phrase "preferably but not necessarily," are used synonymously herein to consistently include the meaning of "not necessarily" or optionally. "Comprising," "including," and "having," are intended to be open-ended terms.

What is claimed is:

1. A method to manufacture a head stack assembly for a disk drive, the method comprising:

  attaching a head gimbal assembly that includes a flexure tail having a plurality of flexure bond pads to an actuator that includes a flexible printed circuit (FPC) with a plurality of FPC bond pads;

  folding each of the plurality of flexure bond pads upon itself such that the flexure tail is substantially thicker at each of the folded flexure bond pads;

  aligning the plurality of flexure bond pads with the plurality of FPC bond pads;

  introducing an adhesive material that includes a plurality of electrically conductive beads of substantially similar size between each of the plurality of flexure bond pads and corresponding ones of the plurality of FPC bond pads; and

  bringing a thermode tool into contact with the plurality of flexure bond pads after folding, with the thermode tool pressing the plurality of flexure bond pads against the plurality of FPC bond pads for a period.

2. The method of claim **1** wherein the flexure tail comprises a structural layer, a dielectric layer, and a conductive layer, and wherein a thickness of the structural layer is less than 20 microns, a thickness of the dielectric layer is less than 15 microns, a thickness of the conductive layer is less than 15 microns, and a total folded thickness at each of the plurality of flexure bond pads is at least 60 microns.

3. The method of claim **1** wherein pressing the plurality of flexure bond pads against the plurality of FPC bond pads during the period arranges the plurality of electrically conductive beads in a monolayer with each of the plurality of electrically conductive beads in electrical contact with one of the plurality of flexure bond pads and the corresponding one of the plurality of FPC bond pads.

4. The method of claim **1** wherein the thermode tool includes a flat surface that is substantially larger than any of the plurality of flexure bond pads.

5. The method of claim **1** wherein the thermode tool transfers heat through the plurality of flexure bond pads during the period, and raises the temperature of the adhesive material during the period.

6. The method of claim **1** wherein folding precedes aligning the plurality of flexure bond pads.

7. The method of claim **1** wherein aligning the plurality of flexure bond pads precedes folding.

8. The method of claim **1** wherein introducing the adhesive material comprises depositing the adhesive material on to the plurality of FPC bond pads prior to aligning the plurality of flexure bond pads.

9. The method of claim **1** wherein introducing the adhesive material comprises depositing the adhesive material on to a first side of the plurality of flexure bond pads after folding and prior to bringing the thermode tool into contact with an opposing second side of the plurality of flexure bond pads.

10. The method of claim **1** wherein folding each of the plurality of flexure bond pads upon itself comprises simultaneously folding all of the plurality of flexure bond pads by folding a terminal region of the flexure tail upon itself.

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